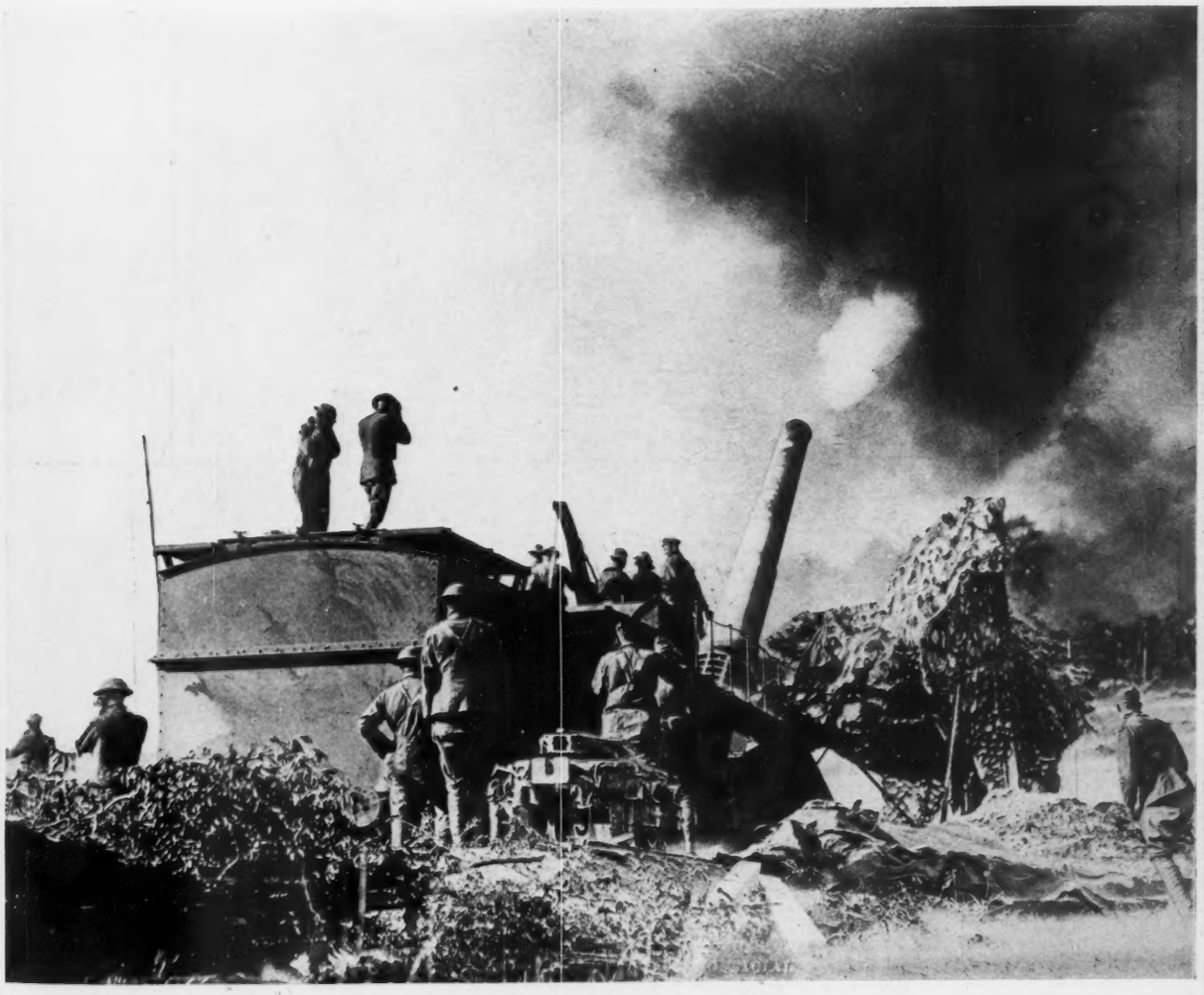
UREAU OF STANDARDS
MAY 9 1921

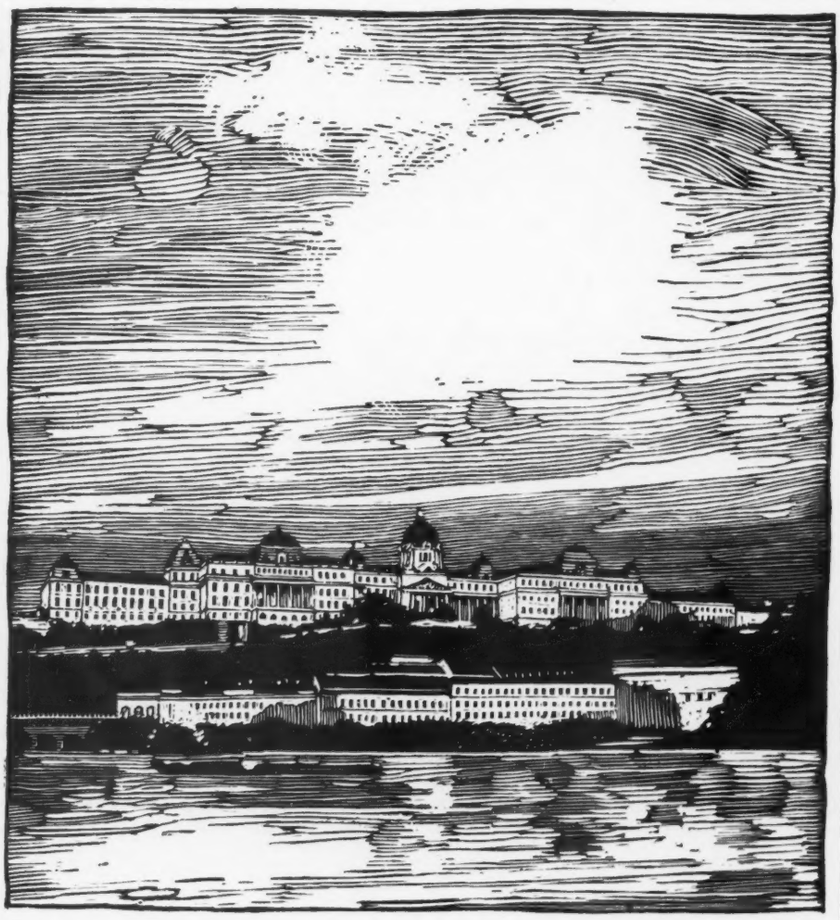
The Tech Engineering News



A 340 mm GUN IN ACTION

See page 27

VOL. II MAY, 1921 No. 2



The WORLD'S WORD for ELEVATOR SAFETY

The WORLD'S WORD for ELEVATOR SAFETY

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BUDAPEST, HUNGARY

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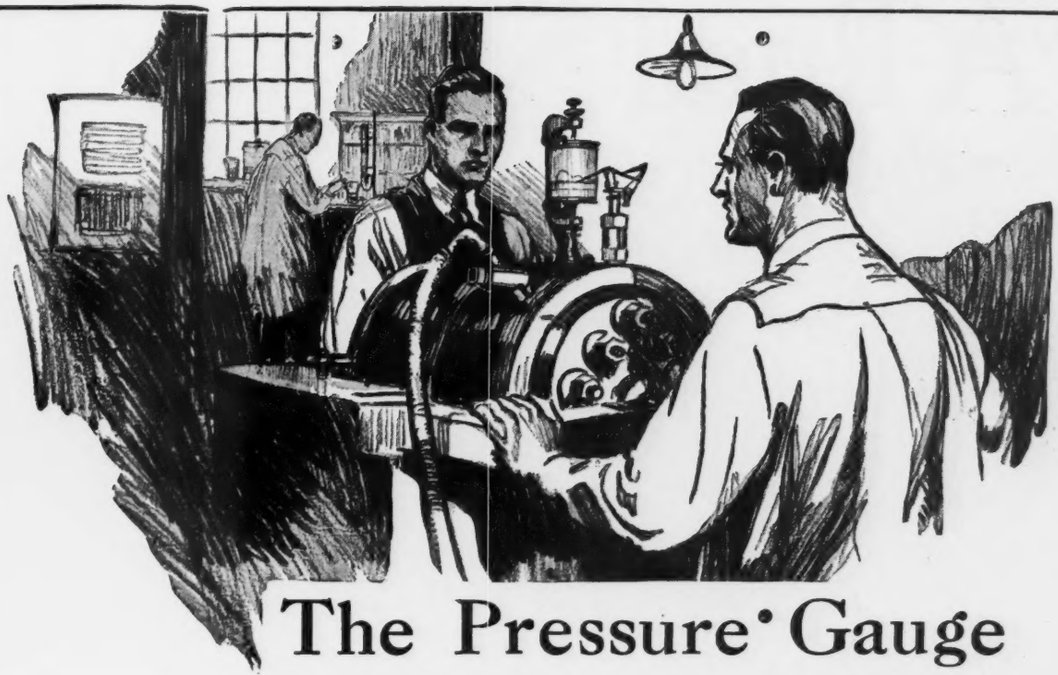

The Pressure Gauge

Out of the thousands of men who use Hercules Dynamite daily probably very few ever think of the experimental work that is done to make this dynamite meet their needs exactly. Yet this work is of vital importance in the maintenance of high standards.

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A Rural Safeguard
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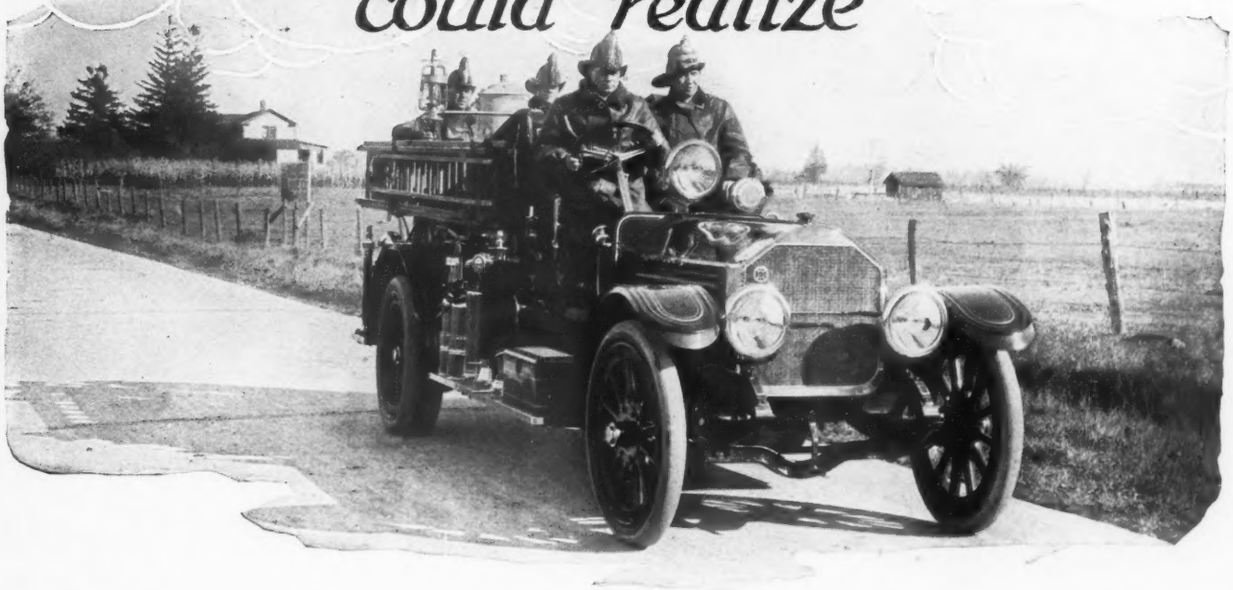

ON THE good roads of the future will come to rural communities every safeguard, every convenience, every substantial contribution to better living that restricted transportation facilities have hitherto limited to the city.

Let your vote be a recognition of these facts—let it be a recognition of the city, town, county and state officials who believe in and work for good roads. For remember that nothing can be a more fitting mark of national and community progress than complete—and permanent—highway systems.

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KOEHRING COMPANY Milwaukee Wisconsin

Contractors who own Koehring Mixers deserve recognition for Dominant Strength Concrete

The Tech Engineering News

Volume II
Number 2

CAMBRIDGE, MASS., MAY, 1921

Price 20 Cents
$1.25 Per Year

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Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass. under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920.

THE TRAINING CAMP FOR RESERVE OFFICERS

By W. H. IRWIN '21 and V. N. KRUSE '21

After completing a required two year course in Military Science, a student may, if he so desires, enter an advanced course of two more years, in which time he learns the fundamentals of any unit of his own choice. The advanced course includes a six weeks summer camp where the theory of the classroom may be carried out in practice on the field. This article is meant not only for the two hundred men from Tech who expect to attend the various camps this summer, but also for all those who are interested in the new method which Uncle Sam has adopted to prepare competent officers for time of need.—Editor.

When a man decides to take the advanced course in Military Science he joins that particular branch of the service which appeals to him and which will help him in his professional work. Tech is very fortunate in having several units, all of which are allied to engineering work.

The first of these branches to be established after the War was the Coast Artillery. This division was active through the school year of 1918-19, and in the summer of 1919 sent twenty-three men to the first C. A. R. O. T. C. Camp at Fort Monroe, Virginia. In 1920 Tech's representation was thirty-nine men.

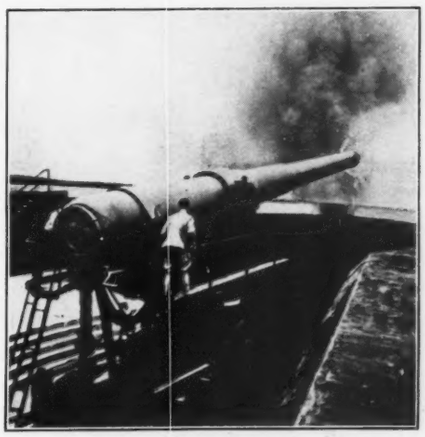
The first Ordnance Camp opened in 1920 at the Aberdeen Proving Ground, Md., and was attended by thirty-eight men, twenty-five of whom were from Tech. In addition to the Coast Artillery and Ordnance camps, there are, of course, the Engineers and Signal Corps camps, as well as the newly established Aviation Camp. These all are very popular and in general that which follows will apply to them as well as to the Coast Artillery and Ordnance.

Fort Monroe stands on a small point of land near Old Point Comfort, commanding the entrance to Hampton Roads and Chesapeake Bay. Here gathered, last summer, from nineteen colleges, three hundred and fifty men, to learn the "lore of the Oozlefinch"—the message of the Big Gun.

Aberdeen Proving Ground has its northern border near the town of Aberdeen and extends south along Chesapeake Bay. The main part of the camp is about thirty-five miles from Baltimore, so week end passes permit traveling to New York or Washington. One may ride to Aberdeen on the Proving Ground Railroad and take a B. & O. or Pennsylvania train from there.

There are, of necessity, certain preliminaries—a physical examination, the issue of clothing and equipment (which is accompanied by considerable conjecture as to the proper usages and disposal of the various articles acquired). When the wily mattress is safely encased within its cover and the cosmaline is removed from the hidden crannies of the rifle the new arrival wanders down to the Y. M. C. A. for the evening movies and begins to feel very much at home.

Thereafter work begins in earnest. First call at Ft. Monroe is at 6:15 and reveille fifteen minutes later. There follows mess, a half hour for housekeeping requirements, and at eight the call for work. There are four main subjects of instruction. Artillery drill consists of practice on the guns and in the plotting rooms. "Coast" artillery under recent developments has come to be a misnomer, for the Heavies include not only the coast armament but also the major calibre field pieces and the Railway Artillery service. Twelve inch mortars and disappearing guns, railway mortars, and the famous G. P. F. were all fired in target practice by the students last year. For a week the entire camp moved to Camp Eustis to emplace and fire a battery of twelve inch mortars.

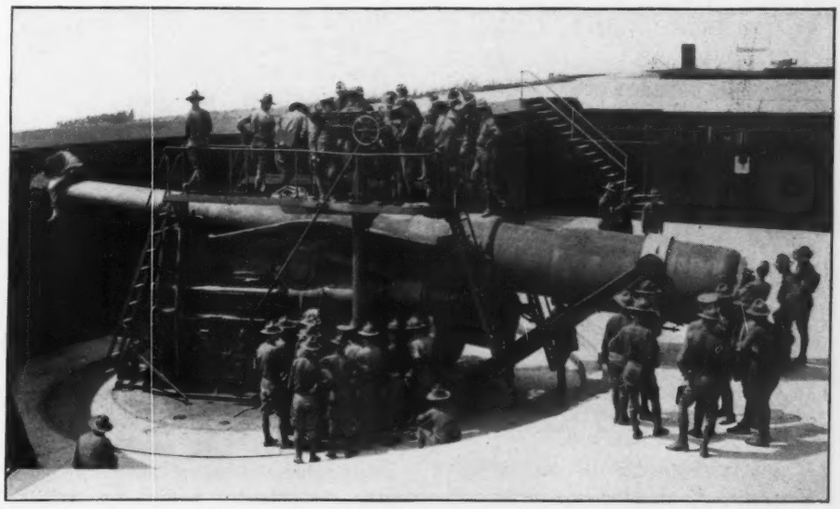


12-INCH DISAPPEARING COAST DEFENSE GUN

Note the remarkable smoke cup at the muzzle of the gun. This is the only official photograph of a smoke cup.

The second subject of instruction is Motor Transportation, which includes laboratory work on engines, transmissions, and ignition systems. The students are taught—by actual practice—how to drive passenger cars, motor trucks, and caterpillar tractors. The course in Tactics involves motor truck rides all over the surrounding country. The fourth major course is Orientation, which in less enlightened communities goes by the more comprehensible name of surveying. Entire mornings are devoted to these subjects. The afternoon's work is less exacting. It may be an hour or two on Field Engineering, Sig-

(*Continued on Page 40*)



LEARNING THE LORE OF THE "OOZLEFINCH"
Getting first-hand information at Fort Monroe, Va.

AEROGRAPHY AND AERONAUTICS

By ALEXANDER McADIE, M. S., M. A.

A. Lawrence Rotch Professor of Meteorology, Harvard University, Director Blue Hill Observatory

Until forty years ago, Man's knowledge about the air in which he lives was surprisingly small, and much of what he thought he knew about it then has since been proved to be false. The pioneer in the exploration of the air, and one of the founders of the modern science of Aerography, was Abbott Lawrence Rotch, a Tech man. He built and maintained the Blue Hill observatory, for many years the only institution of its kind in the country. On his death in 1912 he left the observatory to Harvard University, and Professor McAdie was chosen as his successor. Professor McAdie, the most prominent aerographer in America, points out how the study of the air is of the utmost importance, especially with regard to the coming aerial navigation.—Editor.

During the spring vacation, a small party of Tech men visited the Observatory at Blue Hill. The Hill as is generally known, is about ten miles due south of Cambridge, and on clear days the Observatory can be seen from the upper floors of the Tech Buildings. The Commonwealth gets its name from this hill in Milton, for the Indian tribe which dwelt in this section was known as the Massa-ad-chuseuk; which has been corrupted to Massachusetts. The meaning of the name is probably Great Blue Hill.

This visit of members of the staff of the "Tech Engineering News" brought back to the memory of the Director of the Observatory a trip to the summit made nearly 40 years ago by himself, then a student in physics at Harvard, and a young Tech undergraduate studying mechanical engineering. Even at that early date Lawrence Rotch had planned the erection of an observatory on the summit of Blue Hill; which is the highest land (196 metres above sea-level) within ten miles of the sea, from Maine south.

A word may be said here about the way in which Rotch came to go to Tech. His father, grandfather and all male members of his family were Harvard men. His cousins (one of them now President of Harvard) and close friends were all affiliated with the oldest and best known of American Universities; and so when the young man made known his decision to study at Tech, there was some surprise; for admirable as the institution was in 1879, it was far from being the Tech of 1921. The decision, however, was never regretted; and graduating in 1884, Rotch later became an important member of the Corporation. He also received an honorary degree from Harvard and was appointed Harvard's first Professor of Meteorology.

ABBOTT LAWRENCE ROTCH

Founder of the Blue Hill Observatory. M.I.T. '84. Member of the Corporation 1891-1912.

The Observatory was built in 1884 and was ready for occupation February 1, 1885. There was no similar institution in this country at the time; and for many years it remained the one and only research observatory for the study of meteorology; and Rotch himself the only one to hold a chair in the subject.

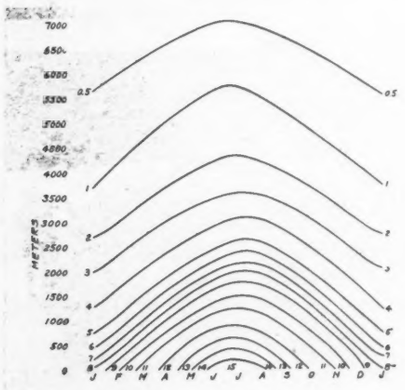
Happily other universities are now establishing professorships and giving the subject its proper place in the curriculum.

One can not here enter into any extended mention of the work that has been done at Blue Hill, or even summarize the long list of scientific contributions by the Director himself and the very able men who have served as observers, assistants and research investigators. Professor Rotch not only provided the best instrumental outfit obtainable, but gave those employed at the Observatory every opportunity to advance. Throughout his life he held true to the purpose of his undergraduate days, namely, to establish an observatory where independent research might be encouraged, and where the work was to be as much as possible, free from official, or even academic, routine and restriction.

Pioneer in the exploration of the air, it was natural that Rotch in the course of his many visits to European observatories, should meet and form a firm friendship with one of his own type, M. Leon Teisserenc de Bort, a Frenchman of Scotch descent. These two, with their observatories at Trappes and Blue Hill, did more to advance our knowledge of upper air conditions than the combined efforts of various national weather services.

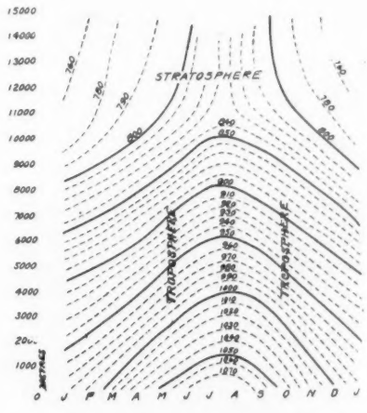
Let us consider for a moment the significance of one great discovery which came from the work of these two aerographers. The atmosphere before their time was regarded as an envelope of air in which the higher one went, the lower the temperature fell. On the contrary we now know it to be a fact that our atmosphere is a double envelope,—so to speak—a lower one in which the decrease of temperature with elevation holds true up to about 9 kilometres with a temperature limit near 800 kilograds (—55 C.) and an upper region with no temperature change. (See chart showing the mean temperature at different heights throughout the year).

And here we must explain the temperature scale used. Aerographers had not gone very far with upper air temperatures before they realized that



WATER VAPOR IN KILOBARS

A megabar = a megadyne/cm² = 1 atmosphere
A kilobar = a kilodyne/cm² = .001 atmosphere
A bar = a dyne/cm² = .000001 atmosphere



TEMPERATURE in KELVIN KILOGRADS — ALTITUDE in METRES

1000 KK = 273° A

neither the Fahrenheit nor Centigrade scale was convenient because of the large number of readings where the temperature was below zero; and hence minus signs had to be used. For some years the Absolute-Centigrade was used; but lately a new scale, originated by the writer, has been found very serviceable. Briefly the zero is the absolute zero or absence of heat point corresponding to the value—273.03 C. on the hydrogen gas thermometer. The absolute zero it will be remembered, is the thermodynamic one; but as the above value indicates, there is no practical difference on the two scales. On the Kelvin-Kilograd scale, starting from the absolute zero, the freezing point of pure water at the pressure of one megabar atmosphere is 1000. No degree signs are used; as these belong properly to angular measures. We thus have a temperature scale that meets the requirements of upper air work.

To return now to the great discovery of the existence of a lower and upper atmosphere, that is, the troposphere and the stratosphere, note how there is a transition from horizontal stratification of the air at a temperature 800 Kk. to a vertical stratification. In other words the temperature does not fall with elevation; but remains practically constant, or the condition may be called isothermal. This upper shell of air has indeed been called the isothermal layer; but it seems much better to preserve and use the name given by de Bort, stratosphere. What looks like a paradox is the discovery (which Rotch had much to do with) that the coldest place "on earth" is "in the air" over the equator, at a height of about 14 kms. The bottom of the stratosphere is highest over the equator and lowest (6 to 7 kms.) over the poles.

Now where does all this come in for the aeronautical engineer? Let us take but two instances of the many which will suggest themselves to all students of aviation.

Rohlfs on September 18, 1919, at Mineola, went up in an airplane to a height of 10,508 metres (34,475 feet) as indicated by altimeter. Of course all altimeters are correct only for a mean temperature of 1037. Correcting for the true temperature of the air column, which was 950, the true height comes out only 9646 metres (31,646 feet).

Schroeder on February 26, 1920, made according to altimeter, 11,479 metres (32,527 feet). There is a difference of only 270 metres between these two remarkable flights; but one man penetrated the stratosphere and experienced his coldest weather, pretty cold too, 797 (—67 F.) before he reached his ceiling.

Again, the great Zeppelin raid of October 29, 1917, failed primarily because the German aerographers, while forcasting correctly the surface winds and temperatures, failed to realize the on-coming northwinds of high velocity and the bitterly low temperatures (850 to 900) at the high levels. Of the great air fleet of 13 ships, 7 met with disaster, not before, but after bombing London and the large manufacturing cities of England.

And so Germany lost the mastery of the air, more than off-setting Great Britain's supremacy on the sea, because the German aerographers made a mistake.

In time of peace, hardly less than in time of war a knowledge of the structure of the air is important. Forecasts of weather so long as they remain based upon the synoptic chart of ground values only, must fail of verification at times; because we now believe that storms have their origin not at ground or at the bottom levels of the air but rather in the higher levels. There is a close correlation between the temperature and pressure of the air in the upper part of the stratosphere; many of the coefficients exceeding 0.90.

Again we must know, not alone for accurate forecasting, but for the countless problems connected with heating, drying, proper ventilation, and maintenance of health how the water vapor is distributed at various altitudes.

We can know nothing definite about rainfall until we know both relative and absolute humidities at various heights.

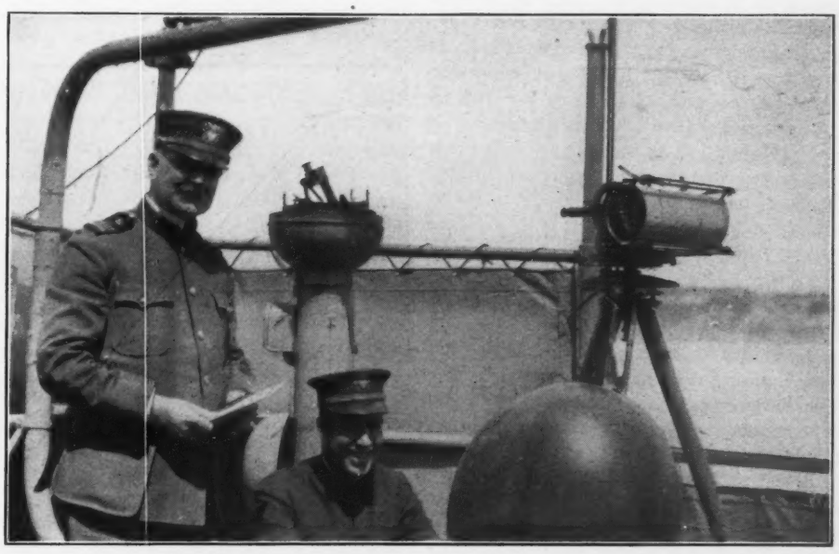
The expansive force of the vapor in kilodynes per square centimeter or kilobars is shown for various levels, on the accompanying chart.

Every engineer must know as much as he can about the absolute humidity, that is, the weight of the vapor in grams per unit of volume if he would rightly estimate possible rainfall maximum rates, evaporation rates, etc.

For the aeronautical engineer, it is enough at present to call attention to the new facts which aerographers have discovered, namely, that at about 8 kms. the value of the density of the air is practically the same all over the globe at all seasons. At about 20 kms. the pressure is uniform and seemingly independent of surface pressure. So we begin to see why the highest winds are found just below the stratosphere.

Let me conclude with a quotation from a recent paper by Europe's leading aerographer, Sir Napier Shaw, in a discussion of the origin of the energy of storms.

"Consequently, my view at the present time is that the energy of a cyclone is due originally to convection in a region with a suitable law of variation of velocity with height; it is guarded at the top by the isothermal condition of the stratosphere, and on the sides by the balance of pressure and rotation. It is open to slow attack at the bottom on account of the friction of its winds with the surface, and unless its energy can be maintained by additional convection it must perish. I do not think that a traveling cyclone carries its supply of rain for long distances; it probably manufactures it out of the material in the lowest levels which it has to pass over. But it uses the energy so supplied first to form a secondary, and afterwards to absorb it or to be absorbed by it."



LIEUT. COMMANDER McADIE AND LIEUT. ASHBROOK ON THE U.S.S. BALTIMORE
Determining the speed and direction of wind at flying levels during trans-Atlantic flight of N. C. boats.

WHAT SAFETY ENGINEERING REALLY IS

By SIDNEY J. WILLIAMS
Secretary and Chief Engineer of the National Safety Council

Every engineer who gets out into a real shop finds that he has two things to deal with—materials and men. It is a surprising thing that most colleges teach a great many things about materials, but nothing at all about men. For example, they teach something about the fatigue of materials—that with repeated loading, a piece of steel or wood will finally break down under much smaller load than would have been required to break it in the first place. But they teach nothing about the fatigue of men at the end of a hard days work.

Another thing that the engineer learns about is to protect his material against harmful exposure. He would not think of leaving a carload of portland cement out in the rain all night and expecting it to be ready to go to work for him in the morning. How about the laborer who spends his night in an unventilated room in a crowded, noisy tenement house? Can he expect him to be ready to go to work and work efficiently in the morning? They do not teach anything about that in college. Big employers have learned that it pays to provide comfortable, pleasant houses for their workmen, with plenty of light and air and garden space, and that men living in such houses are better workmen and do more work. They have found also that a man is not an efficient workman if he has chronic indigestion brought on by eating greasy food because his wife does not know how to cook; or if he has spent a sleepless night because of a sick baby; and they have found that it pays, in dollars and cents, to send a visiting nurse into the home of that workman to teach his wife how to cook and to take care of the sick baby.

One more thing about which something is taught in college is buying materials according to rigid specifications. Bridge steel must contain precisely a certain percentage of carbon; rail steel is different. But nobody is taught in college how to hire men according to specifications. Not long ago a man operating a locomotive crane on the construction of an ore dock ran his crane and himself off the end of the dock into Lake Superior, and the company found afterwards from his widow that he was an epileptic. Big companies nowadays examine men before putting them to work and they do not put epileptics on travelling cranes, nor men with weak hearts at work lifting heavy weights. They hire their men according to specifications, just as they purchase their materials.

In short, the big employers, and the engineers who are doing big things in the world, have found out that they must handle men just as carefully as they handle materials. But what has all this to do with Safety? Obviously to keep a man at work and efficient, one of the things to do is to keep him from being killed or injured.

To show this to be important, it is only necessary to realize that during the nine-

SAFETY FIRST

This has become the watchword in modern industry and is indicative of the great interest in safety that has arisen in the last generation. On account of this, Safety Engineering, one of the newest phases of engineering, has grown very rapidly. Mr. Sidney J. Williams, Chief Engineer of the National Safety Council has explained what Safety Engineering is and how it has reduced the number of industrial accidents.—Editor.

teen months that we were at war, the number of persons killed by accidents in this country was more than twice the number of American soldiers who gave up their lives in battle; also the accidental deaths in industry alone during that period were nearly as many as the American lives lost on the battlefield.

A dozen years ago a few of our large manufacturing companies began to recognize that accidents to their employees were costly and wasteful and that they interfered with production and took away men who could not easily be replaced. They began to study the causes of these accidents and how they could be prevented. It was found that in many cases the cause was defective machinery or equipment and frequently a correction of these defects not only prevented further accidents but also increased production

The companies which did this pioneer safety work a dozen years ago also found many accidents which at first they charged to carelessness of the employee—for example, a man is pushing a truckload of material through the factory and hits a post or an obstruction in the floor, causing something to fall off the truck and possibly hurt his foot. On further study, however, it was found that often the real cause of these accidents was insufficient lighting, or too narrow a passageway, or uneven floor, all of which made it unnecessarily difficult for the trucker to do his work safely. In other words, it was poor engineering rather than carelessness. When these conditions were remedied, the accidents were largely decreased.

But when all this had been done, there were still a large number of accidents that seemed to be due entirely to some reckless or foolish act on the part of the injured man himself or some fellow workman. In the old days the company would have said, "If a man gets hurt through his own foolishness, we are sorry, but we can't help it." Our pioneer safety men, however, recognized that "passing the buck" in this way would not save the money that these accidents were costing the company, and so they studied this class of accidents as carefully as they had studied the others and they were delighted to find that these accidents also could be prevented, simply by teaching the workman how to do his work more carefully. They found that most workmen are fatalists about accidents. They think of an accident that happens to the other fellow as something that, if it should happen to themselves, cannot be avoided. This feeling was overcome by a systematic campaign of education whose aim was, first, to show the workmen what a serious accident really means to himself and his family; and second, to show him to what a large extent the workman himself is responsible for the accidents which happen.

It was found that most of these accidents due to carelessness or ignorance could be prevented in the following way: One or more Safety Committees were organized—a General Safety Committee of Executives and, in most cases, a Workmen's Safety Committee in each important department. The General Safety Committee had charge of the entire safety campaign and had the duty of bringing home clearly to the superintendents, general foremen, etc., the extent to which careful supervision is necessary in order to prevent accidents. Workmen's Committees had two general duties: one, to investigate and report on accidents which happened in their department; the other, to make regular inspections for the detection not only of unsafe conditions but also of unsafe practices on the part of the men. These inspections taught the men on the Workmen's Safety Committee to recognize how often men do things in an unsafe way, and their investigation of actual accidents brought home to them forcefully the fact that most of these accidents could not have been prevented by mechanical safeguards but were due to unsafe habits of work on the part of the man who was injured or on the part of some one else. Both these lessons were lessons which could not have been taught to the workmen by their superiors but which they soon learned through actual experience.

Another essential feature of the safety organization was found to be a Safety Inspector, a man especially appointed to give all or part of his time to regular inspections and to follow up the carrying out of the improvements determined on

(Continued on Page 34)

WILLIAM BARCLAY PARSONS

Here is a man you ought to know. He built the first subway; made surveys in the "Closed Province" of China; served on the Panama Canal Commission; and organized the First Volunteer Regiment of Engineers for the Spanish War. In the Great War he aided in the organization of the Officers Reserve Corps; was among the first Americans ordered overseas; saw distinguished service as commander of the 11th Engineers; and was awarded the British D.S.O. His life and opinions will interest you.—Editor.

On April 15th Colonel Parsons celebrated his sixty-second birthday. In appearance and activity, however, he gives the impression of being well under fifty. Altogether one could not find a better example of what energy, hard work, and ambition, together with genius, can accomplish.

Colonel Parsons did not become an engineer by accident, nor as the result of a sudden decision made while in college. From his earliest childhood all things mechanical and scientific had fascinated him. As a little boy he used to go out walking with his father in New York, and his greatest delight was in going to 42nd Street, where the Grand Central Terminal now stands, and watching the trains for Boston and other points being made up. In those days the station was in the neighborhood of Madison Square, and after the passengers had boarded a train, the cars were hauled by horses, one by one, up to 42nd Street where the train was made up, and the engine attached.

At the age of ten, Barclay Parsons was taken to England, where he remained for six years. During this time he studied for college with a private tutor. With this preparation, and his natural aptitude for learning, young Mr. Parsons had no difficulty in entering Columbia with the class of '79, being then sixteen years of age. After graduating from college he studied Civil Engineering at the School of Mines for three years.

Being convinced of the necessity of practical experience as well as theoretical training in the making of a well-rounded engineer, he accepted a small position with the Blosburg Coal Company in 1881 and spent his last summer before graduation at the Company's Pennsylvania mines.

On graduating from the School of Mines, Mr. Parsons had hoped to obtain a place with the New York Central Railroad, but was unable to do so, and joined the Erie road instead. This turn of events was perhaps a slight disappointment at the time, but it turned out to be a blessing in disguise. With the smaller company the young engineer had a greater variety of work, a larger scope for the development of his ability and individuality, and a more comprehensive view and understanding of the entire business of railroading than he could have obtained with any very large organization.

In 1885 Mr. Parsons took up consulting work in New York City, and met with considerable success. As a result of his proven ability as an engineer, and his interest in the entire subject of metropolitan and interborough transportation, he was made Assistant Chief Engineer of the Rapid Transit Commission which was appointed in 1891 to attend to the planning and construction of the first New York subway.

This Commission, however, proved inefficient and in 1894 it was dissolved and a new one appointed with Mr. Parsons as Chief Engineer. Under his leadership the plans for the subway were soon completed, although actual construction was not commenced until 1900.

Meanwhile, however, Mr. Parsons was by no means idle. In 1898 he went to China and made surveys for the newly

WILLIAM BARCLAY PARSONS

projected Hankow-Canton railroad. This work took him a distance of 1200 miles across Hunan, the "Closed Province" of China.

After this unusual experience Mr. Parsons returned to New York and gave a renewed impetus to the work of the Rapid Transit Commission. As a result of his efforts the first subway was completed and put into operation in 1900. The system consisted of two main lines, one on the east side of the city, and one on the west, connecting the business district with the residential and suburban quarters. In spite of the many extensions of Rapid Transit service which the increase in population has necessitated during the last twenty years, these two original lines remain to this day the main arteries of communication in New York, and testify to the skill and far-sightedness of their designer.

A few of the positions which he held during the ensuing years will give some idea of the work in which this able man has been constantly engaged. In 1904 he was made a member of the American Panama Canal Commission, and the following year was appointed to the International Board of Advisory Engineers on the Canal. In the same year, 1905, he was appointed Advisor to the Royal Commission on London Traffic, together with Sir Benjamin Baker and Sir John Wolfe Barry. This was a distinguished position, and one which no foreigner had ever before held.

Not only is Colonel Parsons a great engineer, but he is an able organizer and leader as well, and his services in a military line have fully equalled his accomplishments in civil engineering. Always a firm believer in preparedness, and realizing the importance of engineering in modern warfare, he organized in 1898 the 1st Regiment of Volunteer Engineers for the Spanish War. He received a commission as Captain in this regiment, and subsequently was appointed Chief of Engineers in the National Guard of the State of New York.

When the world war broke out Colonel Parsons was one of the first men in this country to realize that we would inevitably be involved, and to urge preparedness. In 1915 he was appointed Chairman of a Joint Committee of Engineering Societies to provide for the use of engineers in time of war. This body encountered opposition, but its labor was not in vain, for it aided materially in the organization of an Engineers' Reserve Corps and of the entire Officers' Reserve Corps as authorized in the National Defense Act of 1916.

As a reward for his eminent services in this matter, Mr. Parsons was made a Major in the Reserve Corps, and was one of the first Americans to be ordered overseas. In July, 1917 he was attached to the 11th Engineers, and promoted to Lieutenant Colonel, and in May, 1918 succeeded to the command of the Regiment with the rank of full Colonel.

During the nine months that the Regiment served with the British, it saw action at Cambrai, in the Somme Sector, and in Northern Picardy. Later, being transferred to the American front, it took part in the Saint Mihiel and Meuse-Argonne offensives.

For his services, Colonel Parsons received the Distinguished Service Order from the British Government. Among other decorations which Colonel Parsons has received are those of Chevalier of the Order of the Crown of Belgium, the Telford Gold Medal from the Institution of

(Continued on Page 44)

GYROSCOPES AND THEIR APPLICATIONS

The magnetic compass has not been improved much since Columbus discovered America. It does not point to the true north but points to the magnetic north—a spot somewhere near the northern end of Hudson Bay. Moreover, this spot is continually moving in three distinct and different ways. Then too, the magnetic field of the earth changes as one goes from place to place. In consequence of this, gyroscopic compasses are more reliable.

However, before discussing gyroscopes, it is perhaps best to get a few general ideas clearly in mind. Any wheel rotating at high speed about its own axis, and free to place itself in any plane, is called a gyroscope. One of the first things observed about a gyroscope is that it will tend to remain in its own plane of rotation unless acted upon by an outside force. If an outside force is applied to the gyroscope, the axis of the gyroscope will take up a new position. The path of travel of the gyroscope to this position being the line representing the resultant force of the rotation of the gyroscope and the applied force. This phenomenon is called precession. If the gyroscope is made pendulous or has a weight hung on itself and is placed above a larger gyroscope, the fundamental property of which is to remain in its plane of rotation, it will tilt the weight relative to the surface of the earth; then gravity, exerting a pull on this weight, will cause the application of an outside force on the smaller gyroscope, which will make it precess towards the axis of the larger gyroscope. When the force of gravity is equal to the precession tendency, the smaller gyroscope will be parallel with the axis of the larger gyroscope, and we therefore have the principle of the Gyro-Compass.

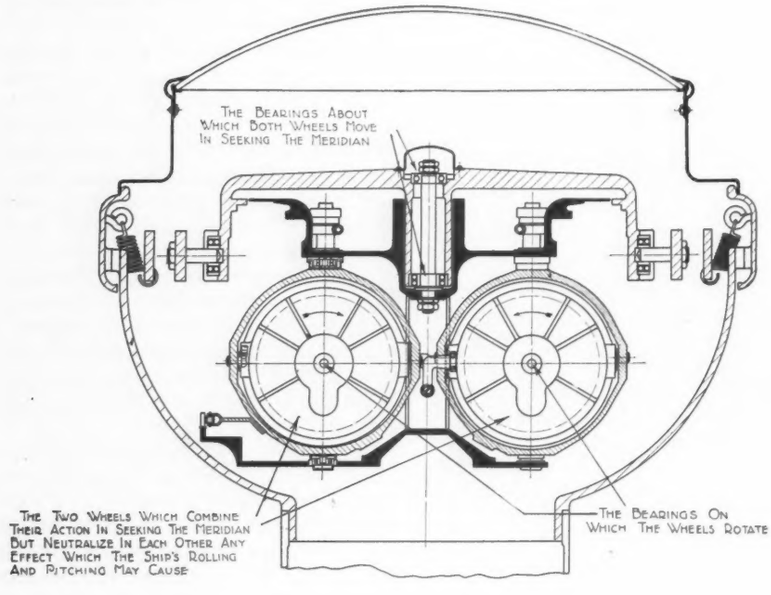
Briefly speaking, the Gyro-Compass depends on four things:

1. Fixity of plane.
2. Rotation of the earth.
3. Gravity.
4. Precession.

When the Gyro-Compass is up to speed and the earth is rotating the gyroscope maintains its fixity of plane, thus raising the weight and allowing gravity to pull on it. Therefore, as the resultant of 1, 2, and 3, we have precession. Keeping these points in mind, the advantages of the Gyro-Compass are briefly as follows:

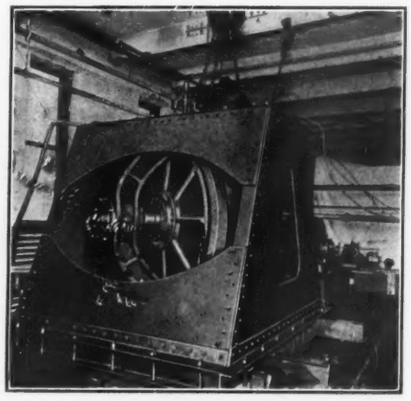
1. The Gyro-Compass, unlike the magnetic compass, points to the true north, always and under all conditions, magnetic or otherwise.

2. There is freedom from calculation. Whenever the ship's course is changed the navigator must calculate the corrections to be applied to the magnetic compass reading because of changes in the earth's magnetic field Mistakes are easily made, some of which may throw the ship as much as 200 miles out of its course. Quite contrary to this the reading of the Gyro-Compass is always direct.


THE BEARINGS ABOUT WHICH BOTH WHEELS MOVE IN SEEKING THE MERIDIAN
THE TWO WHEELS WHICH COMBINE THEIR ACTION IN SEEKING THE MERIDIAN BUT NEUTRALIZE IN EACH OTHER ANY EFFECT WHICH THE SHIP'S ROLLING AND PITCHING MAY CAUSE
THE BEARINGS ON WHICH THE WHEELS ROTATE

CROSS SECTION OF A GYROSCOPIC COMPASS BOWL

3. After the navigator has made the calculations, the magnetic compass is corrected by manipulating compensating magnets. This is an operation requiring such a high degree of skill that only trained men called Compass Adjusters are qualified for the work. The Gyro-Compass is practically free from compensations.



A GYROSCOPIC STABILIZER
How a large gyroscope may be installed in the hull of a ship to act as a stablizer.

4. The ship's magnetism is eliminated As a steel ship moves through the earth's magnetic field, its induced magnetism changes. There is also a certain amount of permanent magnetism in the ship's hull. These must be allowed for with the magnetic compass. It is needless to say that such an effect is not felt on the Gyro-Compass.

5. The influence of the cargo is eliminated. The character and disposition of the cargo has a large influence on the magnetic compass which must be corrected. The Gyro-Compass would still point to the true north even if the vessel were carrying a consignment of permanent magnets.

6. A ship heading north, if rolled to port, will place all the magnetic material of the ship eastward of the compass. This pulls the north end of the needle to the east. The action and effect would be just the opposite on a roll to starboard. The result is that the needle is caused to oscillate. The helmsman will consequently steer over a sinuous course. A Gyro-Compass does not oscillate with the rolling of the ship. Thus the helmsman can steer over a straight line. Due to these considerations ships equipped with Gyro-Compasses have saved from one to ten per cent of the average schedule time required when steering by magnetic compass.

8. There is a warning of unreliability. Magnetic storms exert a vari-

able influence upon the ordinary compass. The navigator is constantly subject to the feeling that his compass may not be accurate—that he cannot depend on it. A gyro-compass is built so that as soon as it fails for any reason an electric bell is rung and the navigator thus knows that it is not to be depended upon until repaired.

Gyro-Compasses are generally built with one master compass and several repeaters. The master compass is usually located within the hold in some protected spot. The repeaters are placed on deck at the various positions where they will be useful. They are electrically connected to the master compass and exactly reproduce all of its readings.

Gyroscopes are also used for stabilizing ships at sea. This is an adaptation of the second principle mentioned above. The advantages of the stabilizer are easily seen. It assures a calm passage, no matter what the weather conditions are. It eliminates the stresses and strains in the hull for it is estimated that if the vessel is stabilized, the strains are from 1-6 to 1-4 less than they would be if she rolled freely under the same conditions. It results in a considerable saving of fuel for the modern turbine only works efficiently when well down in stiff water. As the gyroscope keeps the ship steady, and therefore keeps the turbines in stiff water, a greater amount of fuel goes into propulsion than would if the boat rolled. It prevents the loss of cargoes. Especially is this true of such cargoes as horses and cattle on the hoof.

In conclusion it can be said that the gyroscope, because of its use as compass and as a stabilizer, is eliminating the inaccuracies of navigation, thereby saving time, insuring the ship, the cargo, and lives of the passengers and crew.

ANNOUNCEMENTS, U. S. CIVIL SERVICE EXAMINATIONS

Position

Mechanical Engineer, $3000. For duty in the Bureau of Entomology, Dept. of Agriculture, Tallulah, La. Work in connection with the construction of machinery for the poisoning of the boll weevil, etc., and in general machine shop administration.

Requirements

Study of Mechanical Engineering; five years' experience in theory and practice of M. E.; citizen of U. S.; age, under fifty.

Applicants obtain Form 1312 from local Civil Service Board and file same at Washington before May 17, 1921.

EMPLOYEES COOPERATIVE PLAN

The question of a Works Committee for the Dennison Manufacturing Co. was first discussed at a mass meeting of the employees in July, 1919. At that meeting a committee was chosen to draw up plans for organizing a Works Committee and in September, at another mass meeting, the recommendations of the committee were accepted almost without a change. Thus the plan as adopted was built up by the employees themselves and not handed down to them ready-made by the Management.

The conception of this plan and the development of all its details were the work of the employees. The Management's only part was in the approval of the thorough and well balanced work of the committee. How well the employee's committee did their work can be judged by the fact that since its inception it has been found necessary to make but few changes in the plan as originally adopted and that from the very first the committee has been able to function effectively.

The plan calls for a General Works Committee, composed of members elected from the various departments by the employees of those departments. All employees who have been with the company for six months or more, and are able to read and write, are eligible to vote, the voting being done by secret ballot on the company premises and on company time.

From this General Committee a Central Committee of twelve members is elected to represent the various divisions of the factory and to confer with the representatives of the Management on all questions of policy through the Conference Committees. These Conference Committees have from two to six members, and the Management and employees are represented by an equal number of members on each committee. The standing committees are eight in number and are as follows:

Committee on Procedure
Committee on Publicity & Education
Committee on Hours, Wages & Promotion
Committee on Buildings & Facilities
Committee on Housing
Committee on Unemployment
Committee on Cooperative Buying
Committee on Health & Safety

Special conference committees to take up matters not within the province of the standing committees may be appointed at any time by the Committee on Procedure. All questions of policy which are instituted either by the Management or by the Works Committee, are first referred to the Committee on Procedure, which in turn refers it to the proper Conference Committee. Here the question,—whether it be the management of the Lunch Room, the ringing of time clocks, the payment of overtime, or what-not,—is thoroughly discussed and a report submitted to both the Management and the Works Committee. This report is not binding until both parties accept it, either as submitted, or with amendment.

Grievances of individual employees are not handled by Conference Committees but by another method. The individual who feels that he has a grievance confers first with his foreman and if the matter is not settled to his satisfaction, places it in the hand of his departmental representative. If the departmental representative is unable to secure a satisfactory arrangement from the foreman, the matter is referred to the Divisional representative and through him to the Division Head. If the matter still is unadjusted, it is referred to the Central Committee as a whole and by them to the Management directly. By this method each employee is guaranteed a clear appeal to the highest authority on any matter which he feels is detrimental to his interests.

The foregoing is but a brief sketch of the organization of the Works Committee. It would not be possible to say that it is to be a panacea for all industrial ills, yet on the other hand, it has accomplished much during its short life. Among the subjects which it has taken up and brought through to a successful conclusion are the question of employees profit sharing, the reorganization of the suggestion system, improvement of the Lunch Room service, and unemployment insurance. Above all things it has shown itself to be a constructive rather than a destructive force, its policy has been to cooperate in building up lasting policies rather than to tear down indiscriminately. Altogether it is only fair to say that during its existence it has gone a considerable distance toward accomplishing the objects for which it was instituted, namely:-

a. To promote and maintain just and harmonious relationships between the company and its employees.
b. To expedite the settlement of any matters requiring adjustment between the company and its employees.
c. To further the efficiency and to improve the working conditions of the plant, through the cooperative development of constructive policies by the employees and the Management.

WHERE THE MONEY GOES

THE FINANCIAL ADMINISTRATION OF M. I. T.

The administration of the Massachusetts Institute of Technology for one year requires the expenditure of upwards of one and a half million dollars. Just where this huge sum goes to and incidentally just where it comes from, is a matter of which a careful record is kept, and one which in many ways is quite interesting.

The debit side of the Institute's financial statement can be divided into four main divisions, namely, instruction, maintenance, operation, administration and research, in order of magnitude. These items are exclusive of depreciation and interest on investments, and form a grand total of $1,396,000. The major portion of the instruction expense is incurred in the salaries of the 58 full professors, 82 associate and assistant professors, 110 instructors, and 95 assistant instructors composing the instructing staff. To recompense these men, some of them also for summer school services, costs $751,000, or 58% of the income from tuition fees. The salaries of the professors range from $2,600 to $6,000; of instructors, from $1,400 to $2,500. The staff accessory to teaching requires $19,000 and departmental supplies cost $75,000. 3% of the tuition is devoted to the upkeep of the research laboratories, in which many members of the faculty are doing valuable work.

The maintenance and operation of the Institute's big plant is the most interesting and the most complicated expense item, and the Superintendent of Buildings and Power, Mr. Smith, is in supervision of a multiplicity of activities which few realize. The staff of two hundred or more at his disposal is composed of carpenters, painters, electricians, plumbers, locksmiths, etc., down to the 38 janitors who clean the 1,200,000 sq. ft. of floor and the 8 window washers that keep the 200,000 sq. ft. of glass spotless. The total cost of such building service is approximately $150,000. An equal sum is necessary to maintain the power plant, the latter providing not only heat, light, and ventilation, but also the means for operating the steam and machine tool laboratories and for producing compressed air and suction in the chemical and physical laboratories. The magnitude of the power development can better be appreciated when one considers that the plant burns 30 tons of coal a day; that the annual consumption of electricity is 1,750,000 kilowatt-hours of A. C. and 75,000 kilowatt-hours of D. C.; and that the volume of space to be heated and ventilated in 12,617,000 cu. ft.

Conspicuous among the other operation expenses is a telephone bill of $10,000 a year for the four hundred odd telephones in the buildings. Janitors' supplies (lamps, etc.), trucking, repairs and similar items call for $128,000 more; and insurance, advertising, and printing account for $22,000. It is interesting to note in connection with the latter figure that the insurance rates are materially lowered by the mere fact that all of the janitors and watchmen can be concentrated in the main lobby within five minutes.

The actual administration of the Institute entails a printing bill of $18,000 and a salary item of $93,000, the former covering the publication of the several catalogues, schedule cards, etc., and the latter representing the payroll of the administrative officers and their assistants.

$1,396,000

What happens to your tuition fees,—the third side of the Death-and-Taxes triangle? How much goes to teach you, and how much to wash the 200,000 square feet of windows? The Research Department of the T.E.N. has dscovered the facts, and we pass them on to our readers, feeling that many of them share the Editor's curiosity.—Editor.

Diminutive in comparison but notably effective is the $42,000 devoted to special statement is composed normally of

The credit side of the Institute's financial statement is composed normally of three main items: tuition fees, rentals of all kinds, and the income from invested funds. The tuition charge of $300 a year forms an aggregate of $744.-000, applied in accordance with the following table:

Instruction	$161.30	54%
Maintenance and operation	105.90	35%
Administration	23.80	8%
Research	9.00	3%
	$300.00	100%

It has been estimated that the average student has 1440 hours of lecture and preparation per year, 660 of them being preparation. At this rate the cost of each lecture or recitation is about 38c, whereas to meet actual expenses the figure should be 51c, or tuition of $400 instead of $300.

The income from invested funds is about $525,000, and that from the rental of dormitories and lockers $56,000, making a grand income total, with tuition, of $1,325,000.

For purposes of clarity and comparison, a condensed financial statement is reproduced below:

DEBIT		
Instruction		
Salaries of staff		$640,000
Summer schools required		17,000
Staff accessory to teaching		19,000
Departmental supplies		75,000
		751,000
Maintenance & Operation		
Building service		150,000
Power plant		150,000
Janitor supplies, trucking, etc.		128,000
Repairs		32,000
Insurance, advertising		22,000
Telephone		10,000
		492,000
Administration		
Salaries		93,000
Printing for students		18,000
		11,000
Research		42,000
Grand Total (exclusive of depreciation and interest on investment)		$ 1,396,000
CREDIT		
Tuition fees		$ 744,000
Income from funds		525,000
Rentals (dormitories, lockers, etc.)		56,000
Grand Total		$ 1,325,000

WHAT SAFETY ENGINEERING REALLY IS

(*Continued from Page 30*)

by the General Safety Committee. This inspector holds his position permanently, whereas the Workmen's Committees are frequently changed in order to reach the largest possible number of men. In a large establishment the Safety Inspector should be a man with engineering training so that he can work out safety devices, check plans, etc.

The third essential in a campaign to eliminate accidents caused by carelessness, is a set of bulletin boards containing safety bulletins or posters. These are put up where the workmen will see them and if properly maintained they have been very successful in arousing and holding the interest of the men. The secret of success with bulletin boards is to keep them always interesting, always different.

The last of the principal essentials is the instruction of new men. Frequently a new man is hired and put to work on a given job, or even at a machine, without understanding the nature of the job. We realize now that every man should be instructed and should be warned against the possible dangers of his own job and other dangers to which he may be subjected in going around the plant.

This, in brief, is the system of organization and education that was worked out

by the pioneer companies ten years ago. In combination with the mechanical safeguarding and engineering revision which I have previously described, it proved remarkably successful, accidents being reduced by as much as 50 to 90 per cent.

Other companies soon followed the lead of the pioneers in establishing safety departments and conducting safety campaigns. The interest in the subject soon grew to such an extent that these companies, together with government officials and others interested, formed the National Safety Council as a clearing house for information. The council now has a membership of more than four thousand, the great majority of which are industrial companies employing in all over 6,000,000 workmen. The Council publishes a weekly magazine, other publications for the information of executives and engineers, and educational bulletins for posting on bulletin boards. Its activities also include special local work in more than fifty cities where there are Local Councils, of which twenty now have paid local secretaries.

The human problems of industry, including the problem of accident prevention, are by far the most interesting that the engineer has to deal with when he gets out of college. Engineers are already giving this subject some attention. The more attention students give it, the more absorbing will they find it; and they will go out from the university not only better engineers, qualified to hold bigger jobs, but also better Americans.

FREE ENERGY

One of the most interesting of the modern developments in electrical engineering has been made by the Italians. Italy is entirely without coal resources and up to the opening of the war what manufacturing she was able to do was done under hydro-electric power.

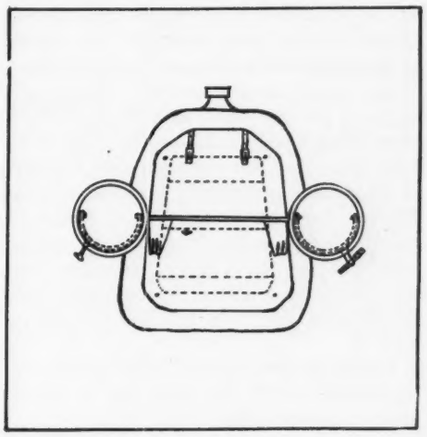
Then one of the Italian engineers hit upon a remarkably ingenious and daring plan. This plan consisted of harnessing Italy's remaining undeveloped source of energy, namely, her volcanos. The experiment was carried out on one of the dormant volcanos north of Vesuvius. Here a shaft was sunk into the heart of the mountain until a subterranian lake of boiling water was struck. The mouth of the shaft was then connected to low pressure engines and the experimenters were successful in generating electric power in this way.

The running expenses of such a power plant are very slight, and as the initial cost is about that of a hydro-electric plant of an equal output, the plan has been extended until at present fifteen Italian cities receive their entire light and power from the energy which is supplied them from nearby volcanos.

RECENT PATENTS BY TECH MEN

RADIATOR-CLOSURE

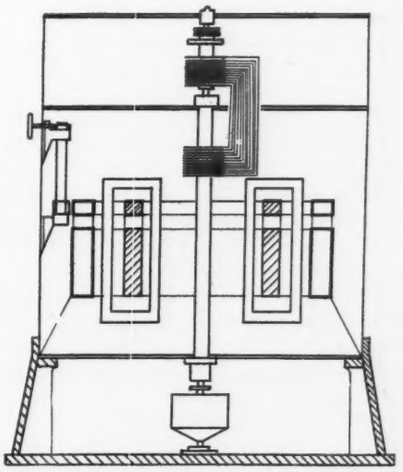
By William R. Strickland '98



This device is intended for an automobile having a cross rod in front of the radiator. A frame of practically the same outline of the open section of the radiator is provided with a drop curtain which covers the open radiator, and spring arms extending from the frame and engaging the cross rod at their free ends hold the frame in place.

DIRECT-CURRENT TRANSFORMER

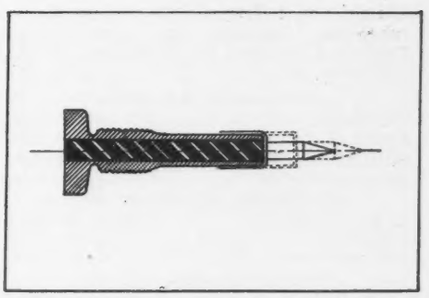
By Arthur F. Nesbit '95



This transformer comprises a main field having integrated primary and secondary cores and a plurality of coils on the primary and secondary cores, a commutating field having a core and a plurality of coils on it. These fields are displaced approximately 90 degrees in phase, the commutating field being angularly adjustable about the axis of the primary and secondary cores. A commutator group is connected to the coils of the secondary core, and collectors provided for the commutator group.

THERMOSTAT

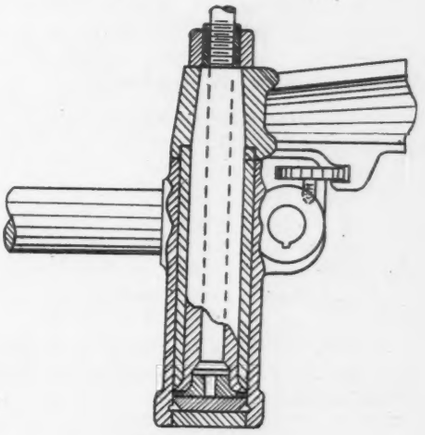
By Stanley M. Udale '06



A thermostat containing an adjustable rod with a drilled passage. A hard rubber rod is inserted in this passage and anchored at one end of the rod and a needle point is attached to the hard rubber at the other end.

STEERING-KNUCKLE

By Herbert W. Alden '93



An axle with an upwardly tapering hole into which fits a knuckle pin with a tapered upper portion fitting foresaid taper and a threaded upper portion projecting above the axle and a nut fitting thereon. A hollow steering knuckle is adapted to receive the knuckle pin. This knuckle has a hardened disk removably mounted thereon, constituting a bearing for the end of the pin.

Recent tests by the U. S. Bureau of Mines have shown that the use of carbon tetrachloride fire extinguishers may and usually does produce small amounts of toxic gases. Thus though it is by no means necessary to discontinue the use of this type of extinguisher, care should be taken that they are not used in confined places where the user cannot escape without breathing the fumes.

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CAMBRIDGE MAY, 1921

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TECHNOLOGY SPIRIT

Technology spirit is an abstract quantity, if we are to believe all that we tell ourselves and our friends. Outsiders, not familiar with Technology, are not to be blamed if their predominant conception of Technology men and Institute Activities is all wrong. After observing certain of our slide rule artists slouching their morose way over the Charles, is it not logical that they imagine our athletic teams as consisting mainly of round shoulders and tortoise shell spectacles, and our activities of a few rusty Olivers and obsolete letter heads? This idea does exist, to a certain extent, and we are to blame for it.

The most deplorable feature of all this is that it is not true. There is such a thing as Technology spirit. Unfortunately, it is rather unequally distributed, but where it exists, it is 100 percent pure, and second to the spirit of no other collegiate institution. Technology activity men, and there are many of them, are rarely outclassed. The spirit that makes them activity men, despite the grind in the classrooms and labs, is real spirit. That spirit overcomes the impression made by the self-complacency over zealous students who in the pursuit of knowledge have lost all true perspective and consequently all loyalty to their Alma Mater. In securing the recent Intercollegiate Conference, there is concrete proof of the fact that Technology activities have attracted the attention of thinking college men in all parts of the country.

Especially are our alumni famous for their spirit. They are all enthusiastic propagandists for Technology. Moreover their support is not entirely of the windy variety; the Endowment campaign evidenced this truth. An increasing number of alumni are attending Field Day, Tech Show, and similar events. They are giving us their wholehearted support and will continue to do so. Why can't more of that spirit be displayed in undergraduate years by those of us now treading in the mill?

The one thing needed to make Technology spirit more general and inclusive is to be found in increased campus life. This may be engendered in several ways: more dormitories, more fraternities, more general get-togethers such as Tech Night and Technique Rush, and more class distinction. Even at the expense of the work done in Institute studies perhaps compulsory engagement in athletics would prove beneficial to the fostering of this spirit.

The need for more dormitories is self-evident, and requires no further comment. There is plenty of fraternity material around the Institute to support at least three more chapters, and fraternities are great propagators of college spirit. Everyone who has been to a Tech Night and who has lived through a Rush, will agree that these are fine affairs and that there should be more of them. The lack of class distinction is the thing that is most striking to the newcomer at the Institute, and it is this lack of distinction that is responsible for much of the present situation. Why not have frosh rules, caps, and all the incidentals attendant upon the freshman year at other colleges? Seemingly petty, these measures might instill an incredible amount of spirit.

Perhaps no men regret the general lack of spirit more than those who most consistently display a sound loyalty to Tech and to all that concerns Tech. It seems a deplorable fact that the stern grind of academic work must take the entire time of so many students. True, C's in studies are a fine thing; but in life no one will care whether it was a C or a P if we can show pep and loyalty to the cause to which we give ourselves. Just now that cause is Tech. Why not break away from the daily routine and prove beyond question that we are capable of that feeling and action which are essential to the fostering of real college spirit?

SHORT COURSES

Culture, breadth of character, and depth of experience are assets to all men. Engineers and scientists are no exceptions. Hence, an engineer must not only be thoroughly trained in his profession, but he must also seek to develop himself as much as possible from the point of view of a general education. An engineer is constructive in his ideas and through the devices he perfects he benefits society. However, to make his creations efficient and effective, the engineer must have something more than his professional training. Purely professional or scientific education is a source of invention and is the means of execution of old processes. Culture, on the other hand, gives the necessary background for the appreciation of life and for the recognition of the needs of society.

In a scientific school of the ordinary type, cultural courses are seldom given Every minute of the student's time is taken up with the assimilation of scientific knowledge. In this school, however, the faculty has attempted to give the engineer a smattering of cultural studies. General studies are popular. They are being accepted each term more favorably by the students. Most general study sections are overcrowded, and in the most popular courses, the number of men taking the courses has had to be limited. These general study courses have been required courses, and most fortunately so, for as a result of the individuals' experience, the desire for more instruction of a similar nature has been created. The most popular courses have been of two kinds, those in which the students have come in direct contact with men of industrial experience and business relations, and those of a strictly cultural nature.

The facts presented above bring out the desirability of establishing short lecture courses open to everybody of such a variety and nature as to satisfy the apparent needs of the engineer. The student of engineering of the present realizes that he must keep up to date. The everyday classroom work acquaints him with the past. The present is not kept before him in accurate and clear statements, but is merely spread before him in veiled arguments of possibility.

Every engineer wants to know current existing facts. Every man has an ideal which he is striving to approach, it may be portrayed by some great man of the present, or perhaps by some great character of fiction.

We are the engineers of the future. We want to know and should know the lives and history of the great men of the present. We ought to be instructed first hand in the meaning and significance of the present problems of the legislator, of the laborer, of the capitalist, and of the banker. Many men are desirous of the chance to discuss and to hear discussed recent books and theories of a non-professional nature. The music-lovers should be privileged to indulge in a course of musical appreciation. The engineer would very easily become an interested politician if facts and actual data were presented to him in a live and interesting way. The cultural instincts of the embryo Technology engineer at the present time have been aroused. Is this not the psychological time to satisfy them?

THE EMPLOYMENT SITUATION

A year ago, THE TECH ENGINEERING NEWS published a series of letters from employers all over the country relative to the situation which graduates would confront upon leaving the Institute. At that time, the outlook was bright because Industry was on the peak of the cycle which it seems to run from dull times to boom times.

At present another series of letters is at hand. The industrial outlook is by no means bright. As a result of the reaction from excessive War-time activity; conditions have approached a crisis. Employers, employees and prospective workers are facing a difficult problem. Especially unpromising is the outlook for the young technical graduate since the number of positions open is very limited. Moreover, competition is to be keen in obtaining anything of technical nature, because older and more experienced men whom the present crisis has thrown out of employment are already in the field.

In June, four hundred Tech men will be facing this situation. While we do not wish to be unduly pessimistic, we cannot avoid the dark side if we present the true facts of the case. If a permanent job is to be landed, the Senior must be up and doing early. Other factors remaining constant, the M.I.T. man should be able to rely upon his degree to a greater extent than men with degrees from other institutions. Let us remember, however, that this is not a time to be finicky in one's choice of employment. Mr. Carle M. Bigelow of Cooley & Marvin says, "My advice to an engineer graduating this year would be to take any kind of a position available at which he can earn his living for a year."

It seems that this advice is excellent. Although we hope for a change in the situation before many months, we cannot look forward to such a change with certainty. This is a time when sacrifices must be made. If the Senior will regard his first year in Industry as a post-graduate course fitting him for efficient service later on, he may be more nearly reconciled in doing work which is not to his liking.

The following letter from the McElwain Shoe Company is typical of many which we have received. Likewise, it evidences the regard which this company holds for Tech men.

Editor,
The Tech Engineering News,
Cambridge, Mass.

Dear Sir:

A forecast of the employment conditions confronting graduates of 1921 cannot be made with certainty. We are now experiencing the greatest industrial depression that the country has ever known. While we hope that the worst is now over, the extent to which business will "come back" in the year 1921-22 is still problematical.

During the past year many manufacturers have been forced to suspend a great deal of their research work and to curtail other activities not absolutely essential to the bare maintenance of plant operations. This readjustment has increased the supply of men available for employment as industrial engineers, production engineers, efficiency engineers, personnel managers or other work designated by similar titles for which Tech men are usually well adapted.

During the Spring and Summer we hope for a gradual resumption of business activities, but do not expect that industry as a whole will be back to full production until the latter part of the year or even later. This situation is going to result in intense manufacturing competition and a continued curtailment of many activities not showing a direct profit. Research work will be carried on, but with only the best type of research workers and only to the extent that it shows definite tangible results and proves itself to be an actual necessity of the business.

A year ago, in writing your paper on the employment situation, we gave you a list of eleven graduates of the Massachusetts Institute of Technology who held responsible positions in our organization and who in themselves served as an answer to the question as to whether there was a field for technically trained men in the shoe industry. Notwithstanding the readjustment which our organization went through in meeting the business depression, ten of these eleven men are still in our organization, and one, a fairly recent graduate of the Institute, has resigned to accept a better opportunity with another concern. Tech graduates have proved their worth in this crisis. We feel sure that there is just as good material being graduated from the Institute today which will be of value to industry in the future.

To the men graduating this year, we would say as we did last year, that the first year spent with a large manufacturing organization is very much in the nature of a post-graduate course. Nearly all of a man's time is spent in assimilating the surprising amount of detail he finds to be learned in connection with the conduct of the business, and in adjusting himself to his position as one of the cogs in the intricate mechanism of a large organization. To the manufacturer he constitutes an investment from which he will receive returns in later years. In our experience Tech men have proved to be a good investment, and with the return of normal business conditions, we hope to have opportunities to offer to men from the Institute.

Yours very truly,

W. H. McELWAIN COMPANY
Winfield L. Shaw,
Vice-President.

A REVIEW OF

"THE DESIGN OF HIGHWAY BRIDGES OF STEEL, TIMBER AND CONCRETE"

—Milo S. Ketchum, C. E., Professor-in-Charge of Civil Engineering, University of Pennsylvania. Second Edition Rewritten. New York: McGraw-Hill Book Co., 1920. pp. 550; illustrated. $6.00 net.

The twelve years since the first edition of this volume was published have seen a greater advancement in methods of highway bridge designing than any previous such period. For this reason the rewriting of the book has entailed not only minor changes in text and the deletion of obsolete practices, but also the addition of extensive material on general concrete construction work and current designs for steel and concrete bridges and foundations. The introduction of this matter has necessarily altered somewhat the sequence and style of the first edition, but has maintained the same coherency that made it so valuable as a consultation book. It is apparent that the makeup has been improved upon as much as the treatment of the subject matter, and the many new cuts and inset plates are excellent.

The volume is divided into four parts and has three appendices, the whole completely indexed and thoroughly illustrated. With a noticeable parallelism to engineering courses, attention is devoted successively to the calculation of stresses in bridge trusses, the design of steel and timber bridges, the design of reinforced concrete bridges and culverts, the construction of highway bridges, and a study of contracting, estimates, and costs. The practical value of the standard designs of steel and concrete bridges is assured by their preparation in the state highway departments of three states (Iowa, Illinois, and Wisconsin), though it seems unfortunate that a broader geographical scope in their origin could not have been effected. Small features which should be appreciated by engineers are subject headings at the top of each page and a cross-referenced index—a happy incorporation of reference value in an authoritative text.

Are you going to be a "drop-forged" engineer?

There are thousands of that kind and, soon or late, they learn with a shock that they can get just about so far, and no further

THREE big eastern university engineering societies held a joint meeting recently. They were alumni men of technical colleges. And they met to discuss the outlook of the college trained engineer.

"The trouble," said a speaker, "is that too many of us are 'drop-forged' engineers. We know our profession; but of Business, to which it is so closely related—we just don't know what it's all about."

In the files of the Alexander Hamilton Institute is the story of a graduate of a great engineering college. With all his training and his degree, he was a "drop-forged" engineer.

> "When I left college I did not know the A B C of how to consider even the simplest of business problems," he wrote.

Upon leaving college, he started to work as an engineer for a big technical firm at $70 a month. He is still with that firm. And this is what he writes:

> "Today I am part owner of the firm and sole manager of it. *This hasn't been due to luck by any means*; but simply by putting into practice what anyone can get from the Modern Business Course and Service of the Alexander Hamilton Institute."

It is not enough to know the technical side alone

The director of a western engineering college said recently: "The most dominant characteristic of the engineering profession is the preponderance of the commercial over the technical."

Step by step, the engineering enterprises that achieve big success, and make careers for engineers, are guided by the same fundamental laws and practices that rule modern business. And thousands of engineers have learned by bitter experience that without business training, technical training carries a man just about so far, and no farther.

A Course whose product is understanding

The Alexander Hamilton Institute was founded by a group of business men and educators who realized that modern business was developing specialists, but not executives; that somehow more men must be taught the fundamentals that underlie the operations of every department of business.

The Institute has only one Course. It takes a man out of college and gives him a working knowledge of all the departments of business.

Such a man receives in a few months of reading what ordinarily would consume years of practical experience. He finds in the Institute a more direct path from where he is to where he wants to be. He has the satisfaction of carrying large responsibilities while he is still young. Naturally and inevitably he earns more than the average man of the same years and education.

For the "drop-forged" engineer who asks himself "Where am I going to be five years from now?" the Alexander Hamilton Institute has an encouraging story to tell. It is the story of the thousands of successful college men—many of them engineers—who have saved the wasted years; men who, thru the Course and Service, have added to their technical equipment the training which makes them understand what business is all about.

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"Forging Ahead in Business" is a 116-page book especially prepared for men who are taking stock of their prospects and wondering what the future may hold for them. It is not a book for idlers, or men of feeble purpose. But to men who seriously want to know what the Course has done for others in positions like their own, the book will be a revelation. It will be sent without obligation. Just send the coupon below.

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IN the shivery tones of melodrama false prophets rise up to assure you that all the wonders of electricity have been discovered, that the industry has had its day, that you should lose no time changing to some younger and less developed profession.

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And now, depend upon it that in 1921 as at any time during the last hundred years, the world is on the eve of important inventions and discoveries and their commercialization in the realm of electricity.

How momentous these developments shall become in the next forty years is largely up to you men now in college. It will fall upon you to work out interconnection systems, to manage water-power projects, to plan electrification of railroads, to extend the lines of communication into new lands.

There are seventy million Americans who do not use electricity in their homes. One of your jobs will be to supply them.

So there is a long-time market for your services, a demand for your utmost energy and enthusiasm and ability.

Your cue is to start now thinking about your work in a big way, building yourself to measure up to the opportunities and the problems that will be your share in developing this greater industry of tomorrow.

* * *

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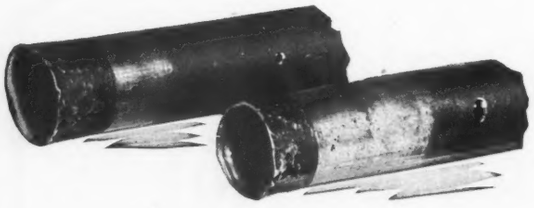

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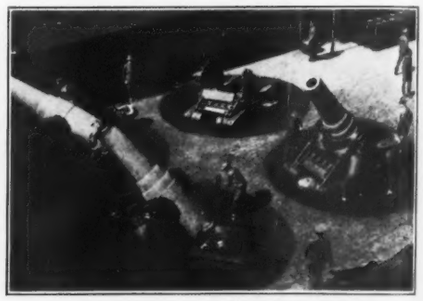
THE TRAINING CAMP

(*Continued from Page 27*)

nalling, or exploring the anatomies of machine guns and rifles. Or perhaps it is a trip to the range on the Amatol (rechristened, with a delightfully Frenchy air, D'Amitall) railroad. At four o'clock all hands turn out in bathing suits for calisthenics, and the day's work is ended.

At Aberdeen, last summer, each day was divided into one or two-hour periods, and the time devoted to lectures, field instruction, disassembling and assembling in the shops and operation



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The projectile from one of these mortars can pierce the armor of any battleship afloat.

of various mechanisms. A typical day's program was as follows: 8:15 a. m. to 9:15 a. m. Recoil Mechanism, 155 mm. Howitzer. 9:15 a. m. to 10.45 a. m. 75 mm. Gun (Lecture, study, firings). 10:45 a. m. to 11:45 a. m. Preliminary Target Instruction. 12:55 p. m. to 4:30 p. m. 75 mm. Model 1897 (Lecture), 75 mm. British (Study), 3 in. 15pdr., Model 1917, (Firings). In general, the first three weeks were spent on artillery, beginning with field artillery on mobile battery platform and taking in the railway mounts and the seacoast guns at the plate range. The next week was spent on tanks and tractors; the week following on the range with rifle and automatic pistol and studying machine gun mechanism. On the artillery platform where field artillery and anti-aircraft guns are proof-fired, projectile velocities were measured and fuses and types of ammunition studied. In the shop, recoil mechanisms and breech blocks were taken down and assembled.

Some of the most interesting work was at the plate range where testing on projectiles for seacoast guns is done. The projectiles are fired at armor plate supported by timbers and backed by sand. In a recent test a newly designed 14 inch projectile striking 14 inch armor at a 20 degree angle passed through practically undamaged.

The work on tractors consists of "breaking" the tracks; taking off the

(*Continued on Page 43*)

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To be admitted to the Institute, the applicant must have attained the age of seventeen years and must pass examinations in Algebra, Plane and Solid Geometry, Physics, Trigonometry, English, French or German. Certificate of preparation in two units of a series of elective subjects is also required. The requirement in History may be met by the presentation of a school record of certificate grade. A division of these examinations between different examination periods is allowed. In general a faithful student who has passed creditably through a good high school, having two years' study of French and German or three years of French or German should be able to pass the Institute examinations.

Graduates of colleges, and in general all applicants presenting certificates representing work done at other colleges, are excused from the usual entrance examinations and from any subjects already satisfactorily completed. Records of the College Entrance Examination Board, which holds examinations at many points throughout the country and in Europe, are also accepted for admission to the Institute.

Instruction is given by means of lectures and recitations, in connection with appropriate work in the laboratory, drawing-room or field. To this end, extensive laboratories of Chemistry, Physics, Biology, Mining, Mechanical Engineering, Applied Mechanics, and the Mechanics Arts have been thoroughly equipped, and unusual opportunities for field-work and for the examination of existing structures and industries have been secured. The co-operative course in Electrical Engineering and that in Chemical Engineering Practice afford an unusual opportunity to combine a technical training with a direct contact with the industries.

The regular courses are of four years' duration, and lead to the degree of Bachelor of Science. In most courses the work may also be distributed over five years by students who prefer to do so. Special students are admitted to work for which they are qualified; and the degree of Master of Science, Doctor of Philosophy, and Doctor of Science are given for resident study subsequent to graduation. Opportunity for research is offered in all the departmental laboratories and in the Research Laboratories of Applied Chemistry, Electrical Engineering, Industrial Physics and Physical Chemistry.

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THE TRAINING CAMP FOR RESERVE OFFICERS

(Continued from Page 40)

rollers, greasing, and adjusting; tuning up carburetors; and operating 5, 10, and 20 ton tractors, as well as the Ford Whippet and 6 ton tanks. These were taken out to a field where obstacles in the way of swampy ground, ditches, stumps and trees were tackled. After this experience everyone had the ability to manoeuvre a tractor in to the shop without taking along part of the wall.

The question of mess touches a delicate point—and meets all requirements satisfactorily. Thanks to last year's legislation the student fares royally on the West Point ration allowance; and is exempted from the notorious offices of K. P.

The features of the camps which arouse great enthusiasm among all who attend are the provisions made for recreation and entertainment. Inter-battery competition is developed to a fine point. There are baseball games, competitive inspections, and field meets. This rivalry is carried into the routine work and even there the spirit of play is predominant. One may go swimming in the bay, and tennis courts are open for use at all times. Evenings and Saturdays riding passes may be obtained and horses taken from the stables. There are several dances and receptions given during the course of the camp, at which Baltimore and Washington girls are "issued." There is plenty to occupy one's time in the evenings. The officers' club, the R. O. T. C. Club, the canteen, the Y. M. C. A., the post theatre, and the neighboring towns offer a wide field of diversion to him who seeks it.

The week-ends offer larger fields. On Saturday mornings there are regularly conducted inspection trips to points of interest, but as a rule the cadets are turned loose for the entire week-end, the only restriction being attendance at Monday morning reveille.

The various camps have achieved a reputation for interest, initiative and accomplishment. Medium in size, they offer many privileges which cannot be expected in larger camps. Located as they are in the center of their particular activity, surrounded by outward evidences of the traditions of their corps, the cadets have acquired a loyalty for their corps and a pride in it as their organization. Add to this the experience and the useful knowledge gained, and it is to be wondered at that after the six weeks none regrets spending a part of his vacation learning military lore in the land of the Ooozlefinch?

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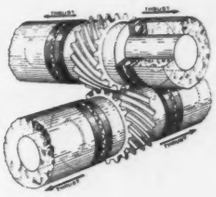

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WILLIAM BARCLAY PARSONS

(*Continued from Page 31*)

Civil Engineers of Great Britain, and the Norman Gold Medal from the American Society of Civil Engineers.

Colonel Parsons has now returned to his general consulting work, and is at present a member of the firm of Parsons, Klapp, Brinkerhoff, and Douglas.

It would be a mere platitude to state that such a man commands our respect and admiration; the facts of his life speak for themselves. Every Tech student is eager to have just such a career, and lots of us would be well pleased with a great deal less. Hence a few words of advice from Colonel Parsons will certainly be of interest.

He says, "Seize your opportunities, make the most of your ability, and study those things in which you are really interested." When asked what to do on graduating from Tech, Col. Parsons' answer was emphatic: "Accept the first position that is offered to you. The important part of a man's early work is not the money he makes, but the experience he gets."

As to the bigger position, Colonel Parsons assures us that we will find it without difficulty after a few years, provided we keep alert and active in the mean time. It is these qualities of ambition, energy, and interest in his work, which have gone far to make Colonel Parsons the great man that he is.

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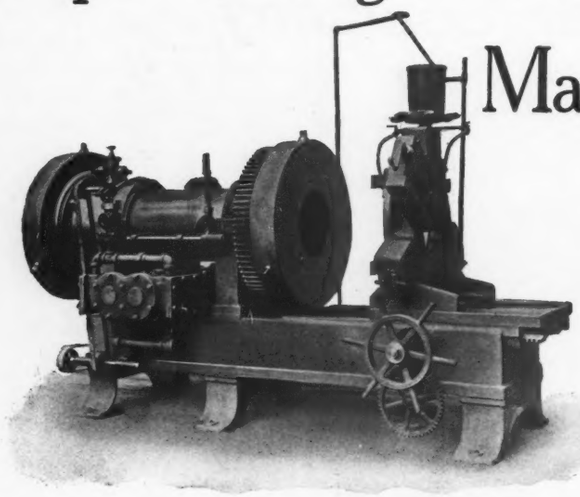

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ENGINEERING NOTES

The civil engineering bureau of the British Ministry proposes to create a great tidal source of power by throwing a dam across the Severn River, where the average tide is 30 ft. According to the Scientific American, the water as it rises will be let in through the dam and on the ebb will flow back through turbines which begin operating when there is a head of about 5 ft. Ten miles from the dam, a great reservoir will be constructed near the river Wye, which runs into the Severn. On the banks of the tidal portion of the Wye, a large pump and power-plant will be constructed, and surplus power at the Severn plant will be used to drive centifugal pumps at the Wye plant. These pumps will deliver water to the reservoir, located at a high level, through a tunnel 4 ft. in diameter and more than a mile long, to be driven through solid rock. The motors for driving the pumps will be arranged to serve as generators when water is fed back from the reservoir, and will provide a continuous output of 500,000 H. P., with a peak of twice as much.

A total of 9,211,295 motor cars, including commercial vehicles, were registered last year in the forty-eight states and the District of Columbia, according to figures compiled by the U. S. Bureau of Public Roads in a study of revenue available for road-building purposes. There were also registered a total of 238,146 motorcycles. The registration and license fees, including those for chauffeurs, operators, and dealers, amounted to $102,034,106.26. As compared with 1919, the data for 1920 represented an increase of 22 percent or 1,645,849 motor cars. In 1920 the number of motor cars registered in the state of New York alone exceeded the total cars registered in the whole of the United States in 1910. The use made of the revenues has changed with the passing years. In 1906, practically none of the money derived from motor vehicles was applied to road maintenance or construction, while in 1920 the budgets for this work amounted to 96 percent, 79 percent of which was expended under the supervision of the several State Highway Departments.

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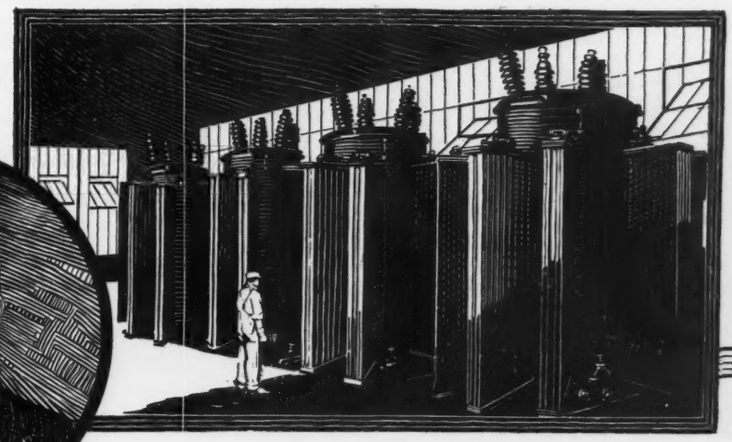

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the founder of the Westinghouse industries

The Vision of This Man

Gave America Alternating Current

Thirty-odd years ago state legislatures were being importuned to prohibit the distribution of alternating current on the pretense that it was dangerous. Today, legislatures are asked only to compel its makers to distribute it more widely and sell it more cheaply.

Times have changed since Westinghouse bought the Gaulard and Gibbs Transformer patents, and brought Alternating Current to America. This was the necessary preliminary step to the tremendous developments that Alternating Current, once known as "Westinghouse Current," has made possible.

To eliminate all the alternating systems and apparatus that are in use everywhere today would set this country back thirty years; but there was a time when all the resources and courage that Westinghouse could command were required to withstand the bitter opposition of those who fostered direct current instead. The whole Electrical Industry now recognizes that there is a proper field for each system, but it was all or nothing in the late '80's, when the question was first raised.

The original alternating current system was hardly practicable, even for lighting purposes. From it, however, have resulted all the modern applications of the alternating current system, the many methods and devices for transmitting current at high voltages and stepping it down to lower pressures by transformers located in connection with the consuming apparatus, whether in the home, in industry, or for the Public Service.

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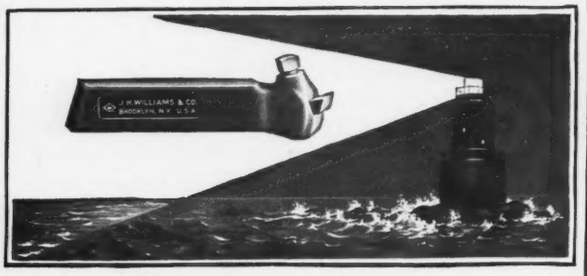

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DAYLIGHT ILLUMINATION.

The angle of refraction being equal to the angle of incident, it is a simple matter to determine the correct angles to use in manufacturing glass which will give good illumination. But for proper industrial plant illumination, there is more to be considered than mere deflection of light. The direct beam of light must be eliminated in order to prevent sun glare, which is objectionable on account of its causing heavy shadows and strong contrasts which decrease the efficiency of employees and necessitate the use of shades which in turn reduce the light to such an extent that daylight illumination any distance from the light source is not sufficient. Therefore, in order to produce a glass which when used in the windows of industrial plants will produce as near to ideal illumination as possible, we must first eliminate the direct rays of the sun by deflecting the light to the ceiling and side walls which re-deflect it back to a distance 25 to 50 feet from the window throughout the entire working area. To accomplish this we have scientifically designed a type of glass which is named "Factrolite."

Factrolite consists of 30 ribs to the inch, running at right angles, forming 900 pyramidical prisms or 3,600 light deflecting surfaces which completely disintegrate the direct beam of light from the sun. Furthermore, the depressions in the surface of Factrolite are so slight that the accumulation of dirt and dust is minimized and can be perfectly cleaned with an ordinary dry scrubbing brush. Incidentally, the cleaning of windows is most important for keeping up production and increasing the efficiency of any industrial plant and should be given more consideration in plant management.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

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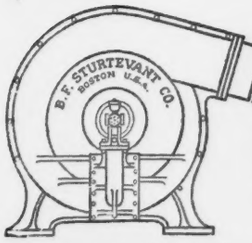

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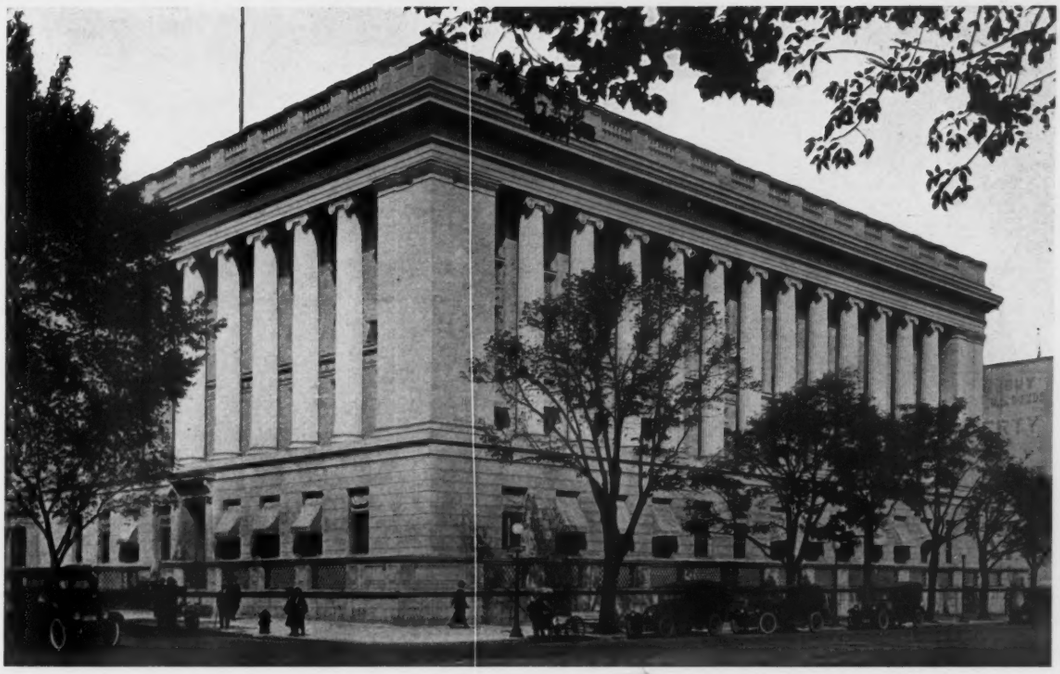

U. S. Treasury Annex, Washington, D. C. *Cass Gilbert, Architect; D. E. Polglase, Mechanical Engineer*

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What Makes the Firefly Glow?

YOU can hold a firefly in your hand; you can boil water with an electric lamp. Nature long ago evolved the "cold light." The firefly, according to Ives and Coblentz, radiates ninety-six percent light and only four percent heat. Man's best lamp radiates more than ninety percent heat.

An English physicist once said that if we knew the firefly's secret, a boy turning a crank could light up a whole street. Great as is the advance in lighting that has been made through research within the last twenty years, man wastes far too much energy in obtaining light.

This problem of the "cold light" cannot be solved merely by trying to improve existing power-generating machinery and existing lamps. We should still be burning candles if chemists and physicists had confined their researches to the improvement of materials and methods for making candles.

For these reasons, the Research Laboratories of the General Electric Company are not limited in the scope of their investigations. Research consists in framing questions of the right kind and in finding the answers, no matter where they may lead.

What makes the firefly glow? How does a firefly's light differ in color from that of an electric arc, and why? The answers to such questions may or may not be of practical value, but of this we may be sure—it is by dovetailing the results of "theoretical" investigations along many widely separated lines that we arrive at most of our modern "practical" discoveries.

What will be the light of the future? Will it be like that of the firefly or like that of the dial on a luminous watch? Will it be produced in a lamp at present undreamed of, or will it come from something resembling our present incandescent lamp? The answers to these questions will depend much more upon the results of research in pure science than upon strictly commercial research.

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